Contaminant Concentrations in Traditional Fuels: Tables for Comparison

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In an effort to provide additional information and data to the regulated community concerning the concentrations of contaminants that may be found in traditional fuels, the following tables present summary statistics for contaminant concentrations in common traditional fuels. Members of the regulated community may find the data presented here useful when comparing contaminants in their non-hazardous secondary materials (NHSMs) to contaminants in the appropriate traditional fuels.[1]

- Use of these tables is not required to demonstrate compliance with the contaminant legitimacy criterion, and the existence of these tables does not preclude the use of other data sources. EPA has organized and presented this data as a service to assist NHSM processors and combustors in making contaminant comparisons. The Agency will periodically update these tables as additional data become available.

- The following three tables cite contaminant data from both the scientific literature and EPA databases for coal, wood/biomass, and fuel oil. NHSMs burned in combustion units are most often substituted for one of these three traditional fuels.

- The two referenced EPA databases, both compiled by the Agency's Office of Air Quality Planning and Standards (OAQPS), together contain approximately 32,000 records of contaminant analyses performed on coal (~17,000), wood/biomass (~12,000), or fuel oil (~3,000) samples prior to combustion. Summary statistics from this comprehensive dataset are displayed separately from other data sources, but persons using these tables to make contaminant comparisons are not constrained to one column or one data source for the appropriate traditional fuel.

[1] All data presented in this document are for individual contaminants for which EPA has information. Please note that targeted revisions to the rule are under development, with the goals of both clarifying the 40 CFR Part 241 requirements and facilitating implementation of the rule as EPA originally intended. EPA is considering including a discussion of contaminant groups (e.g., VOC), an alternate option for contaminant comparisons involving hazardous air pollutant compounds that NHSM processors and combustors may want to consider.

Table 1: Contaminant Concentrations in Coal[1]

Contaminant	Units	Literature Sources	OAQPS Databases[2]		
		Range	Range	Average[3]	Non-Detect Rate
Metal elements - dry basis					
Antimony (Sb)	ppm	0.5 - 10[4]	ND - 6.9	1.7	25 %
Arsenic (As)	ppm	0.5 - 80[4]	ND - 174	8.2	8 %
Beryllium (Be)	ppm	0.1 - 15[4]	ND - 206	1.9	12 %
Cadmium (Cd)	ppm	0.1 - 3[4]	ND - 19	0.6	38 %
Chromium (Cr)	ppm	0.5 - 60[4]	ND - 168	13.4	1 %
Cobalt (Co)	ppm	0.5 - 30[4]	ND - 25.2	6.9	8 %
Lead (Pb)	ppm	2 - 80[4]	ND - 148	8.7	5 %
Manganese (Mn)	ppm	5 - 300[4]	ND - 512	26.2	<1 %
Mercury (Hg)	ppm	0.02 - 1[4]	ND - 3.1	0.09	5 %
Nickel (Ni)	ppm	0.5 - 50[4]	ND - 730	21.5	<1 %
Selenium (Se)	ppm	0.2 - 10[4]	ND - 74.3	3.4	22 %
Non-metal elements - dry basis					
Chlorine (Cl)	ppm	--	ND - 9,080	992	4 %
Fluorine (F)	ppm	--	ND - 178	64.0	9 %
Nitrogen (N)	ppm	--	13600 - 54000	15090	0 %
Sulfur (S)	ppm	--	740 - 61300	13580	0 %
Hazardous air pollutant (HAP) compounds[5]					
Benzene	ppm	ND - 38[6]	--	--	--
Ethyl benzene	ppm	0.7 - 5.4[6]	--	--	--
16-PAH	ppm	6 - 253[7]	--	--	--
PAH (52 extractable)	ppm	14 - 2090[7]	--	--	--
Styrene	ppm	1.0 - 26[6]	--	--	--
Toluene	ppm	8.6 - 56[6]	--	--	--
Xylenes	ppm	4.0 - 28[6]	--	--	--

Sources and Notes:

1. This table includes data for anthracite, bituminous, sub-bituminous, and lignite coal.
2. USEPA, Office of Air Quality Planning and Standards (2011a & 2011b).
3. Averages are weighted averages of individual facilities responding to the OAQPS survey. Averages only include samples above detection limits.
4. Clarke and Sloss (1992).
5. HAPs listed here include only those HAPs with available data. These are not the only HAP compounds considered contaminants.
6. Fernandez-Martinez (2000).
7. Laumann, et al. (2011).

Table 2: Contaminant Concentrations in Wood & Biomass Materials[1]

Contaminant	Units	Literature Sources	OAQPS Databases[2]		
		Range	Range	Average[3]	Non-Detect Rate
Metal elements – dry basis					
Antimony (Sb)	ppm	ND - 26[4]	ND - 6.0	0.9	45 %
Arsenic (As)	ppm	ND - 6.8[4]	ND - 298	6.3	57 %
Beryllium (Be)	ppm	--	ND - 10	0.3	69 %
Cadmium (Cd)	ppm	ND - 3[4]	ND - 17	0.6	32 %
Chromium (Cr)	ppm	ND - 130[4]	ND - 340	5.9	14 %
Cobalt (Co)	ppm	ND - 24[4]	ND - 213	6.5	23 %
Lead (Pb)	ppm	ND - 340[4]	ND - 229	4.5	28 %
Manganese (Mn)	ppm	7.9 - 840[4]	ND - 15800	302	<1 %
Mercury (Hg)	ppm	ND - 0.2[4]	ND - 1.1	0.03	22 %
Nickel (Ni)	ppm	ND - 540[4]	ND - 175	2.8	17 %
Selenium (Se)	ppm	ND - 2[4]	ND - 9.0	1.1	69 %
Non-metal elements – dry basis					
Chlorine (Cl)	ppm	ND - 2600[4]	ND - 5400	259	5 %
Fluorine (F)	ppm	ND - 300[4]	ND - 128	32.4	43 %
Nitrogen (N)	ppm	200 - 39500[4,5]	2200 - 4600[5]	3460	0 %
Sulfur (S)	ppm	ND - 8700[4]	ND - 6100	704	5 %
Hazardous air pollutant (HAP) compounds[6]					
Formaldehyde	ppm	1.6 - 27[7]	--	--	--

Sources and Notes:

1. This table includes data for untreated wood and biomass, including bark, bagasse, hog fuel, and agricultural plant residues.
2. USEPA, Office of Air Quality Planning and Standards (2011a & 2011b).
3. Averages are weighted averages of individual facilities responding to the OAQPS survey. Averages only include samples above detection limits.
4. Energy Research Centre for the Netherlands, Phyllis Biomass database. http://www.ecn.nl/phyllis.
5. OAQPS nitrogen range based on 20 samples from two facilities, whereas Phyllis biomass database nitrogen range reflects the results of 394 studies.
6. HAPs listed here include only those HAPs with available data. These are not the only HAP compounds considered contaminants.
7. T. Hunt (2011).

Table 3: Contaminant Concentrations in Fuel Oils[1]

Contaminant	Units	Literature Sources	OAQPS Databases[2]		
		Range	Range	Average[3]	Non-Detect Rate
Metal elements - dry basis					
Antimony (Sb)	ppm	ND - 15.7[4]	ND - 3.8	3.5	97 %
Arsenic (As)	ppm	--	ND - 13	1.3	72 %
Beryllium (Be)	ppm	--	ND - 19	2.3	73 %
Cadmium (Cd)	ppm	--	ND - 1.4	0.4	75 %
Chromium (Cr)	ppm	--	ND - 37	3.7	65 %
Cobalt (Co)	ppm	--	ND - 8.5	1.1	84 %
Lead (Pb)	ppm	ND - 56.8[4]	ND - 52	4.3	46 %
Manganese (Mn)	ppm	--	ND - 3200	118	49 %
Mercury (Hg)	ppm	--	ND - 0.2	0.02	74 %
Nickel (Ni)	ppm	ND - 50.2[4]	ND - 270	24.1	39 %
Selenium (Se)	ppm	--	ND - 4	0.8	74 %
Non-metal elements - dry basis					
Chlorine (Cl)	ppm	--	ND - 1260	133	35 %
Fluorine (F)	ppm	--	ND - 14[5]	8.5	80 %
Nitrogen (N)	ppm	42 - 8950[4]	2000 - 3000[6]	2250	0 %
Sulfur (S)	ppm	--	ND - 57000	8280	9 %
Hazardous air pollutant (HAP) compounds[7]					
Benzene	ppm	ND - 75[4]	--	--	--
Biphenyl	ppm	1000 - 1200[8]	--	--	--
Cumene	ppm	6000 - 8600[9]	--	--	--
Ethyl benzene	ppm	22 - 1270[8]	--	--	--
Hexane	ppm	50 - 10000[8]	--	--	--
Naphthalene	ppm	ND - 7330[8]	--	--	--
Total PAH	ppm	3900 - 54700[4]	--	--	--
Phenol	ppm	ND - 7700[8]	--	--	--
Styrene	ppm	ND - 320[8]	--	--	--
Toluene	ppm	ND - 380[4]	--	--	--
Xylenes	ppm	ND - 3100[8]	--	--	--

Sources and Notes:

1. This table includes data for fuel oils 1-6, including distillate, residual, kerosene, diesel, and other petroleum based oils. It does not include data for gasoline or unrefined crude oil.
2. USEPA, Office of Air Quality Planning and Standards (2011a & 2011b).
3. Averages are weighted averages of individual facilities responding to the OAQPS survey. Averages only include samples above detection limits.
4. U.S. EPA (1999), Appendix B.
5. OAQPS fluorine range based on a limited dataset (59 samples from only five facilities). Detection limits for non-detect results ranged from 19 to 300 ppm, all higher than the maximum recorded value of 14 ppm.
6. OAQPS nitrogen range based on a limited dataset (12 samples from only one facility).
7. HAPs listed here include only those HAPs with available data. These are not the only HAP compounds considered contaminants.
8. USEPA (2000).
9. World Health Organization (1999).

References

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4. Hunt, Tim. Written communication from Tim Hunt of American Forest & Paper Association to Jim Berlow of EPA, July 14, 2011.
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8. USEPA, 2000. *EPCRA Section 313, Industry Guidance: Electricity Generating Facilities*; February 2000; EPA 745-B-00-004.
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11. World Health Organization (WHO). 1999. "Concise International Chemical Assessment Document 18." Accessed July 2011 at http://www.inchem.org/documents/cicads/cicads/cicad18.htm#PartNumber:6